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Helminth Community Structure of Four Species of *Lepomis* (Osteichthyes: Centrarchidae) from an Oligohaline Estuary in Southeastern Louisiana

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ABSTRACT: A total of 141 centrarchids, *Lepomis macrochirus* ($N = 65$), *L. punctatus* ($N = 45$), *L. megalotis* ($N = 17$), and *L. microlophus* ($N = 14$) was collected from an oligohaline estuary in southeastern Louisiana and examined for adult helminths. Eight helminths (4 Trematoda, 2 Nematoda, 2 Acanthocephala) were recovered from the gastrointestinal and urogenital tracts of these hosts. The compound community of these estuarine hosts differed greatly from that of freshwater centrarchids. Two of the 3 most abundant helminths, the trematodes *Barbulostomum cupuloris* Ramsey, 1965, and *Genarchella* sp., have not been reported in freshwater centrarchids and seem to be restricted to an estuarine environment. The remaining helminths, *Crepidostomum cornutum* (Osborn, 1903) Stafford, 1904, *Phyllodistomum pearsei* Holl, 1929, *Camallanus oxycephalus* Ward and Magath, 1916, *Spinitectus carolini* Holl, 1928, *Leptorhynchoides thecatus* (Linton, 1891) Kostylew, 1924, and *Neoechinorhynchus cylindratus* (Van Cleave, 1913) Van Cleave, 1919, are common parasites in freshwater centrarchids, but in general, with the exception of *L. thecatus,* their prevalence and abundance were low and their impact on the compound community minimal. *Lepomis punctatus* displayed the highest and *L. microlophus* the lowest levels of helminth diversity. Overall, there were differences in helminth species richness and diversity among the component community of these 4 hosts, and these differences were probably the result of host diet. Interspecific interactions among helminths did not play a significant role in structuring the infracommunity of these hosts.
KEY WORDS: parasite, helminth, Centrarchidae, *Lepomis,* estuary, Louisiana, community, site selection.

Holmes and Price (1986) recognized that helminth community structure varies greatly and that the make-up of each community may be regulated by a myriad of biotic and abiotic factors. However, they suggested that helminth communities may be generally characterized as being isolationist or interactive, with each community displaying unique attributes. Several factors that contribute to the development of isolationist communities were discussed by Kennedy et al. (1986). They concluded that, in general, fish hosts harbored a depauperate helminth fauna when compared with other taxonomic groups such as birds because of the simplicity of their enteric system, their ectothermic nature, low vagility, and diet.

Extensive surveys of the helminth fauna of freshwater centrarchids (Bangham, 1938; Bangham and Venard, 1942; Hare, 1943; McDaniel, 1963; McGraw and Allison, 1967; Spall, 1968; Becker and Houghton, 1969; Harley and Keefe, 1970; Meade and Bedinger, 1972; McDaniel and Bailey, 1974; Cloutman, 1975; Jilek and Crites, 1980) have shown that the helminth communities of these hosts display low species richness, and in most cases the helminth species are low in abundance and phylogenetically distant, suggesting that the helminth communities of centrarchid hosts fit an isolationist community model. This conclusion is further supported by Goater et al. (1987), who showed that the composition of the community by phylogenetically unrelated helminth species may be a contributing factor to the isolationist nature of the helminth communities of salamanders.

Although the helminth fauna of freshwater centrarchids has been surveyed extensively, studies that utilize community measures (i.e., index of similarity, diversity index, and evenness) are lacking. Furthermore, no quantitative study has been done on the parasites of freshwater centrarchids when they occur in an estuarine habitat. We have utilized community measures to characterize the helminth community of 4 *Lepomis* species that occur in the oligohaline Lake Pontchartrain/Lake Maurepas estuary.

Materials and Methods

A total of 65 bluegill, *Lepomis macrochirus* Rafinesque, 1819, 45 spotted sunfish, *L. punctatus* Valenciennes, 1831, 17 longear sunfish, *L. megalotis* Rafinesque, 1820, and 14 redear sunfish, *L. microlophus* Gunther, 1859, was collected from a 1.1-km section of the Interstate-55 canal located between the south bank of Pass Manchac and Ruddock, Louisiana, in St.

John Parish. This man-made canal is part of the Lake Pontchartrain/Lake Maurepas estuary, an oligohaline system located in southeastern Louisiana.

In order to minimize temporal variation within the helminth communities of these hosts, all 141 adult specimens were collected by angling within a 3-mo sampling period from 26 May to 26 August 1991. Most hosts were necropsied within 48 hr of capture; however, a few specimens were frozen and examined at a later date. The sex, weight, and standard length of each host was recorded, and the stomach, pyloric ceca, intestine, and urinary bladder were examined for adult helminths. To determine helminth site selection, and the possible presence of competition, the intestinal tract was partitioned into equal thirds before worm counts were made. All helminths were processed using standard parasitological procedures. When present, the gut contents of the hosts were collected, preserved in 70% ethanol, and identified later. Abbreviations used for all helminth species are found in Table 1.

Parasite data did not meet the parametric assumption of normality. Therefore, differences in helminth abundance between male and female hosts and correlations of helminth intensity with host length were tested using nonparametric tests. In addition, Friedman tests were utilized to determine site selection within the intestinal tract of the hosts.

The Shannon-Weiner diversity index (Shannon, 1948 as cited in Zar, 1984) was used to calculate the helminth diversity of the component community of these 4 hosts. We used t-tests to determine whether statistically significant differences existed among the helminth diversity indices of all host species (Zar, 1984). To compensate for the multiple comparisons necessary to test these differences, the P-value significance was adjusted to 0.008. The component communities were compared using Morisita's index of similarity (Krebs, 1989) and percent similarity. Prevalence, abundance, and mean intensity (Margolis et al., 1982) of all helminths and the mean number of helminth species per hosts were calculated for all host species. Voucher specimens have been deposited in the U.S. National Parasite Collection (Accession Nos. 84483–84490).

Results

Hosts

Among the host species *Lepomis punctatus* (standard length [SL] = 104.11 ± 10.15; range = 84.5–126.1 mm), *L. megalotis* (SL = 103.02 ± 10.42; range = 81.6–117.2 mm), and *L. microlophus* (SL = 125.81 ± 15.71; range = 104.0–155.2 mm), there were no significant differences in standard length between male and female hosts (t-test, $P > 0.05$). Although *Genarchella* sp. was more abundant in male than in female *L. punctatus* (Mann-Whitney U-test, $z = -2.188$, $P < 0.05$), males and females of these 3 host species were pooled for subsequent helminth community analysis. However, a significant difference in standard length was found between male (SL = 122.62 ± 14.59 mm) and female (SL = 113.53 ± 13.92 mm) *L. macrochirus* (t-test, $P < 0.05$). In this host, *P. pearsei* was the only helminth that showed a statistically significant correlation with host length (Kendall's correlation, Tau = −0.043, $P < 0.05$). However, this helminth was so rare (Table 1) that the relationship was biologically unimportant. Therefore, male and female *L. macrochirus* also were pooled for subsequent helminth community analysis.

Helminth community structure

Eight helminth species (4 Trematoda, 2 Nematoda, 2 Acanthocephala) were recovered from the alimentary and urogenital tracts of 4 centrarchid host species (Table 1). *Lepomis macrochirus* harbored all 8 helminth species, whereas only 3 species were found in *L. microlophus*. Five and 6 species of helminths were recovered from *L. punctatus* and *L. megalotis*, respectively (Table 2).

The most common trematodes were *Barbulostomum cupuloris* and *Genarchella* sp. Although they were the only 2 trematodes recovered from all 4 host species, their prevalence, abundance, and mean intensity were greater in *L. microlophus*. Only 3 specimens of *B. cupuloris* were recovered from a single specimen of *L. macrochirus*, and 4 specimens of *Genarchella* sp. were found in 1 *L. megalotis*. The remaining 2 trematodes species were rare; 1 specimen of *Crepidostomum cornutum* and 2 specimens of *Phyllodistomum pearsei* were recovered from *L. macrochirus*. The most common nematode was *Camallanus oxycephalus*, which infected 3 of the 4 host species (Table 1). Overall, this helminth was uncommon within the compound community of these hosts, but it was the most prevalent (52%) and abundant (0.75) helminth in the component community of *L. macrochirus*. In addition, the intensity of this nematode displayed a statistically significant (Tau = −0.29, $P < 0.05$) negative correlation with the standard length of the host *L. megalotis*. *Lepomis macrochirus* and *L. megalotis* harbored *Spinitectus carolini*; however, this nematode displayed low prevalence, abundance, and mean intensity within the component community of both host species (Table 1). The acanthocephalan *Leptorhynchoides thecatus* was recovered from all 4 host species. Although rare within the component community of *L. macrochirus* and *L. punctatus*, this helminth was recovered from 100% of *L. megalotis* and *L. microlophus* and was the most abundant helminth in the component communities of these

Table 1. Prevalence, abundance, and mean intensity (range in parentheses) of all helminths recovered from 4 species of *Lepomis*.

Lepomis species	*N*	Helminth* (site†) Bacu (SI)	Gesp (ST)	Crco (CE)	Phpe (UB)	Caox (CE, SI, LI)	Spca (SI)	Leth (SI)	Necy (SI)
L. macrochirus	65								
Prevalence		1%	20%	1%	3%	52%	18%	3%	5%
Abundance		0.05	0.51	0.02	0.03	0.75	0.29	0.03	0.05
Mean intensity		3—	2.5 (1–11)	1—	1 (1)	1.4 (1–4)	1.6 (1–3)	1 (1)	1 (1)
L. punctatus	45								
Prevalence		36%	13%	0	0	36%	0	24%	13%
Abundance		1.09	1.42	0	0	0.71	0	0.58	0.27
Mean intensity		3 (1–11)	10.6 (2–23)	0	0	2 (1–11)	0	2.4 (1–5)	2 (1–5)
L. megalotis	17								
Prevalence		18%	6%	0	0	35%	12%	100%	12%
Abundance		0.29	0.24	0	0	0.53	0.18	9.94	0.18
Mean intensity		1.6 (1–3)	4—	0	0	1.5 (1–4)	1.5 (1–2)	9.9 (4–31)	1.5 (1–2)
L. microlophus	14								
Prevalence		86%	64%	0	0	0	0	100%	0
Abundance		13.93	8.50	0	0	0	0	31.64	0
Mean intensity		16.3 (1–33)	13.2 (1–54)	0	0	0	0	31.6 (2–88)	0

* Bacu, *Barbulostomum cupuloris*; Gesp, *Genarchella* sp.; Crco, *Crepidostomum cornutum*; Phpe, *Phyllodistomum pearsei*; Caox, *Camallanus oxycephalus*; Spca, *Spinitectus carolini*; Leth, *Leptorhynchoides thecatus*; Necy, *Neoechinorhyncus cylindratus*.

† CE, ceca; SI, small intestine; LI, large intestine; ST, stomach; UB, urinary bladder.

Table 2. Shannon-Weiner diversity index and evenness of the helminth component community of all host species, species richness, and the mean number of helminth species per host.

Lepomis host	*N*	Mean no. of helminth species per host	H′	H′/H′ max	Species richness
L. macrochirus	65	1.0	0.609	0.674	8
L. punctatus	45	1.2	0.643	0.921	5
L. megalotis	17	1.8	0.244	0.314	6
L. microlophus	14	2.4	0.414	0.868	3

hosts (Table 1). A statistically significant correlation was found between this helminth and the standard length of *L. microlophus* (Tau = 0.538, $P < 0.01$). *Neoechinorhynchus cylindratus* infected all host species except *L. microlophus* but showed its highest prevalence, abundance, and mean intensity in *L. punctatus.*

The Shannon-Weiner function showed that the helminth component community of *L. punctatus* had the highest species diversity (H′ = 0.643) and evenness (H'/H'_{max} = 0.921; Table 2). In contrast, the lowest values of helminth species diversity and evenness were shown by *L. megalotis* (H′ = 0.244, H'/H'_{max} = 0.314). With the exception of the comparison between *L. macrochirus* and *L. punctatus* (Student's *t*-test, t = 0.8672, $P > 0.05$), the helminth diversity among all other host species was significantly different (Student's *t*-test, $t > 3.291$, $P < 0.001$; Table 3). Morisita's index of similarity, and percent similarity, showed that the helminth community of *L. microlophus* and *L. megalotis* displayed the highest similarity (Moristia's index = 0.869, percent similarity = 63%), whereas the component communities of *L. macrochirus* and *L. megalotis* were the least similar (Morisita's index = 0.086, percent similarity = 14.2%; Table 3).

Qualitative analysis of gut contents showed that *L. microlophus* (N = 4) fed exclusively on amphipods, isopods, and bivalves. Insects were the primary prey of *L. macrochirus.* Insect remains were collected from 10 of 14 specimens with gut contents (71%), but this host also fed on crustaceans such as amphipods, isopods, and copepods, as well as small fish. Plant material, probably ingested while feeding on insects and other prey, was recovered from 7 specimens. Amphipods were the most common prey (92%) of 12 *L. punctatus* with gut contents; however, insects, sponges, and decapods were also ingested by this host. None of the 14 specimens of *L. megalotis* contained gut contents.

Friedman tests were used to analyze site selection in *B. cupuloris* and *L. thecatus.* These 2 helminths were the most abundant species found within the intestinal tract of their hosts and were chosen to examine whether competition played a significant role in structuring the helminth community. Results showed that these 2 helminths were site specific. The site preference of *B. cupuloris* in the absence of *L. thecatus* was examined in *Lepomis punctatus. Barbulostomum cupuloris* showed a preference for the anterior two-thirds of the intestinal tract. A total of 23 specimens was recovered from both the anterior and middle section of the intestine, but no worms were found occupying the posterior third (N = 13, χ^2 = 9.90, $P < 0.01$). In *Lepomis megalotis,* the site preference of *L. thecatus* was established in the absence of *B. cupuloris.* Totals of 142, 7, and 2 specimens of *L. thecatus* were recovered from the anterior, middle, and posterior sections of the intestinal tract, respectively (N = 14, χ^2 = 22.26, $P < 0.001$). *Barbulostomum cupuloris* and *L. thecatus* were most prevalent and abundant in *Lepomis microlophus* (Table 1); therefore, this host afforded us the opportunity to examine the site distribution of these helminths when concurrent infections were com-

Table 3. The *t*-values of Shannon-Weiner diversity index comparisons, percent similarity, and Morisita's index of similarity among the component community of 4 species of *Lepomis.*

Community comparison	*t*-value	% similarity	Morisita's index
L. macrochirus–L. punctatus	0.867	54.1	0.697
L. macrochirus–L. microlophus	5.228***	20.2	0.173
L. macrochirus–L. megalotis	7.084***	14.2	0.086
L. punctatus–L. microlophus	13.428***	55.7	0.611
L. punctatus–L. megalotis	10.134***	25.1	0.291
L. megalotis–L. microlophus	−4.545***	63.2	0.869

*** $P < 0.001$.

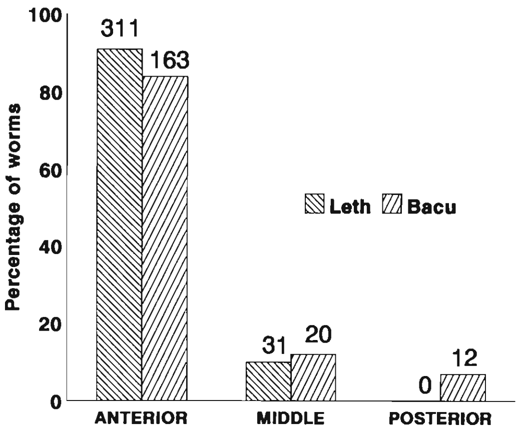

Figure 1. Percentage and total number of *Leptorhynchoides thecatus* and *Barbulostomum cupuloris* recovered from 3 intestinal sections of *Lepomis microlophus* (see Table 1 for abbreviations of scientific names).

mon and abundances were high. Both helminths overlapped in distribution and were recovered mostly from the anterior third of the intestinal tract. Totals of 163, 20, and 12 specimens of *B. cupuloris* ($N = 12$, $\chi^2 = 15.85$, $P < 0.001$) and 311, 31, and 0 specimens of *L. thecatus* ($N = 12$, $\chi^2 = 22.37$, $P < 0.001$) were recovered from the anterior, middle, and posterior segments respectively (Figure 1).

Discussion

Lakes Pontchartrain and Maurepas are part of an oligohaline estuary that serves as a corridor to the Gulf of Mexico. The salinity of this large estuary ranges from 0‰ at the western shore of Lake Maurepas to 15‰ at the eastern shore of Lake Pontchartrain; however, at our study site it never exceeded 3‰. In this environment both freshwater and marine organisms are found. Such a unique habitat afforded us the opportunity to examine the role of ecological associations in structuring the helminth communities of freshwater hosts occupying a brackish water environment.

Unlike any published reports of centrarchid parasite communities, 2 of the 3 most abundant species in the compound community of these hosts were *Barbulostomum cupuloris* and *Genarchella* sp. Neither species has ever been found in centrarchid hosts inhabiting strictly freshwater habitats, and their distribution seems to be restricted to an estuarine environment. Ramsey (1965) described *B. cupuloris* from *L. punctatus* and *L. microlophus* collected from the Lake Pontchartrain estuary. The absence of this trematode and the presence of the closely related *Homalometron armatum* in centrarchid hosts collected from freshwater ponds near the brackish estuary led Ramsey (1965) to conclude that *B. cupuloris* was dependent on an intermediate host restricted to a brackish water environment. This same explanation may account for the presence of *Genarchella* sp., an undescribed hemiurid sharing morphological characteristics with *G. isabellae* (Lamothe-Argumedo, 1977) and *G. overstreeti* (=*Paravitellotrema overstreeti* Brooks, Mayes, and Thorson, 1979) described from Mexican and Colombian freshwater fishes, respectively.

The remaining helminths in the compound community of these hosts have been reported previously from freshwater habitats (Bangham, 1938; Bangham and Venard, 1942; Hare, 1943; McDaniel, 1963; McGraw and Allison, 1967; Spall, 1968; Becker and Houghton, 1969; Harley and Keefe, 1970; Meade and Bedinger, 1972; McDaniel and Bailey, 1974; Cloutman, 1975; Jilek and Crites, 1980). However, with the exception of *L. thecatus,* these helminths displayed low prevalence and abundance. In addition, several adult helminths found in freshwater centrarchid hosts, such as *Rhipidocotyle septapapillata, Crepidostomum cooperi, Homalometron armatum, Pisciamphistoma reynoldsi, P. stunkardi, Phyllodistomum lohrenzi, Anallocreadium pearsei, Spinitectus gracilis, S. macrocanthus, Contracaecum brachyurum, Rhabdochona decaturensis, Capillaria catenata, Proteocephalus* sp., and *Bothriocephalus claviceps* (see Bangham, 1938; Bangham and Venard, 1942; Spall, 1968; Meade and Bedinger, 1972; Jilek and Crites, 1980), were not recovered in our study.

The negative correlation displayed by the intensity of *C. oxycephalus* with the length of *L. megalotis* may be due to an ontogenetic shift in habitat or diet from smaller prey, such as copepods, which serve as intermediate hosts for this nematode, to larger prey as the host increases in size. Among the acanthocephalans, *Leptorhynchoides thecatus* showed a statistically significant correlation with host length in *Lepomis microlophus.* DeGiusti (1949) showed that the intermediate host of this acanthocephalan is the amphipod *Hyalella azteca.* The relationship between helminth intensity and host size may have been a result of an increase in the number of infected amphipods consumed by larger hosts,

or, as Ewald and Nickol (1989) concluded from their study of *L. cyanellus*, infrapopulations of this acanthocephalan may be regulated by the availability of cecal space. The trematode *P. pearsei* was rare, and the statistically significant correlation with host length in *L. macrochirus* was biologically insignificant. Overall, host sex did not play a major role in structuring the parasite community of these centrarchids. Similar results were obtained by Lawrence (1970), Cloutman (1975), and Aho et al. (1991). With the exception of *Genarchella* sp., which was more abundant in male than in female *L. punctatus*, host gender had no effect on helminth abundance.

Parasite community diversity differed among hosts. Bell and Burt (1991) concluded that helminth diversity was correlated with host body size and diet but that body size alone did not account for much of the variation in helminth diversity found among taxa. Diet analyses revealed that, in general, hosts that preyed primarily on benthic crustaceans and fish harbored a more diverse helminth fauna than did hosts that fed on detritus, vegetation, and insects (Bell and Burt, 1991). In general, in our study host size did not affect the abundance of helminth species. Because all of the helminths we recovered have indirect life cycles, we believe that differences among the helminth diversity of these four centrarchids may be attributed to diet. *Lepomis macrochirus*, a generalist feeder (Deselle et al., 1978; Levine, 1980), is exposed to a greater number of potential intermediate host species, thus resulting in higher helminth richness than *L. microlophus*, a specialized predator. In contrast to parasite species richness, differences in parasite prevalence or abundance among the component community of these centrarchids may represent a differential utilization of prey items by these hosts. However, because the mean number of helminth species per host does not seem to be related to diet diversity, we should note that some of the variation in species richness found among the component community of these hosts may be a result of sampling effort (Table 2).

Barbulostomum cupuloris and *Leptorhynchoides thecatus* did show site preference in *L. punctatus* and *L. megalotis*, respectively. Habitat shift within a host is a good indicator of interspecific interaction among parasites (Chappell, 1969; Holmes, 1973; Stock and Holmes, 1988). In *L. microlophus*, concurrent infections of *B. cupuloris* and *L. thecatus* were common and both helminths were highly abundant. In this host, the spatial distribution of both helminths overlapped (Fig. 1) and neither helminth showed a shift from its preferred site, thus indicating a lack of interaction.

As Kennedy et al. (1986) found for freshwater fish in general, the helminth community of estuarine centrarchids in our study was depauperate and displayed attributes of an isolationist community as described by Holmes and Price (1986). Unlike prior surveys of freshwater centrarchids, 2 of the 3 helminths that seem to dominate the compound community of these estuarine hosts do not occur in freshwater habitats. Therefore, the presence of the trematodes *B. cupuloris* and *Genarchella* sp. seems to affirm the importance of ecological associations in structuring the helminth community of these estuarine hosts.

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